Computor Work for the Blind

by

Theodor Sterling, et al.

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ASSOCIATION FOR COMPUTING MACHINERY 211 EAST 43 STREET, NEW YORK, N.Y. 10017

ACM COMMITTEE ON PROFESSIONAL ACTIVITIES OF THE BLIND

REPLY TO:
THEODOR D. STERLING,
DEPT. OF APPLIED MATHEMATICS AND
COMPUTER SCIENCES
WASHINGTON UNIVERSITY
ST. LOUIS, MISSOURI 63130

March 27, 1968

A Note of Caution to Members of the American Association of Workers for the Blind from the Committee on Activities of Blind Programmers of the Association for Computing Machinery -

Dear Colleague:

The spread in opportunities in the computer field for blind programmers has been a source of much gratification to our association. In a scant four years a large number of qualified blind individuals have been trained and become gainfully employed. We fully expect this number to double in each year for a number of years to come.

There are, however, two problems which might prove to be harmful to the further spread in opportunities offered to blind individuals in computer work.

There exist many, many commercial schools that purport to teach programming skills. Almost half of these existing schools are either outright rackets or are simply not qualified to teach programming even to sighted individuals. Of the remaining, only very few schools have the dedication and know-how available to train blind individuals. The Association for Computing Machinery (in cooperation with members of the AAWB) has set up a screening procedure by which schools duly qualified may have their program and procedures evaluated by a group of experts in the computer field and obtain the help and support from our committee needed to mount a successful training program. These schools are screened not only for their training procedures but also for the relevance of their selection of candidates and success in placement. A list of these duly qualified schools may be obtained by writing to the Association for Computing Machinery, Committee on Professional Activities of Blind Programmers, c/o Campus Box 1102, Dept. of Applied Mathematics and Computer Science, Washington University, Skinker and Forsyth, St. Louis, Missouri 63130.

A second obstacle to the orderly growth of properly qualified training facilities lies in the desire of many states to develop such training facilities within their own regions. This understandable desire is leading now to a dilution of effort. A number of local schools have undertaken the training of two, three, or four blind candidates. It has been our experience, however, that a serious program cannot be mounted unless a school is assured of at least sixteen to twenty students a year. To maintain staff, training facilities, space, and the necessary computer programs which translate print into braille, a large investment is required. It has been our experience that well-meaning regional schools who undertake the training of a few blind individuals will drop this work shortly since it proves to be too expensive. In the meantime the qualified and dedicated schools who wish to continue this work are being seriously harmed since their source of students is being dissipated throughout the country.

The Association for Computing Machinery in collaboration with a committee of the American Association of Workers for the Blind produced a brochure on The Selection, Training, and Placement of Blind Computer Programmers in 1965. Copies of this brochure may be obtained by writing to the office of the Association for Computing Machinery, 211 East 43 Street, New York, New York 10017.

I hope this letter will draw your attention to the problems outlined here.

Sincerely yours,

Theodor D. Sterling, Chairman
Committee on Professional Activities
of Blind Programmers,
Association for Computing Machinery

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Computer Work for the Blind

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THEODOR STERLING, Ph.D., MICHAEL LICHSTEIN, FRANK SCARPINO, DIANE STUEBING, and WILLIAM STUEBING

THE REVOLUTION IN technology and knowledge now developing around computers touches every field of business, technical, and scientific activity. For the blind, this revolution holds special significance because it enables them to enter new professions in which they may compete on an even footing—if not with some advantage—with the sighted.

The most immediate profession thus opened to the blind and the one in which a shortage of trained personnel offers the greatest opportunities is that of computer programming. Jobs in this new field cover a variety of skills and levels of sophistication and range from routine work on payroll and accounting procedures to the highly scientific and demanding disciplines of so-called "creative" programming.

The circuitry of a computer permits only crude logical commands, and exploiting this simple logic is a job of much imagination and patient skill. The sophisticated program provides the computer with sets of criteria by which commands are modified depending on certain events during execution and by which sets of instructions as well as data are moved around in core memory; the various steps may eventually cross each other's path so that modification along one set of criteria will alter instructions or data for other criteria. Such errors are difficult to avoid and even more difficult to correct.

Because of his intensive training and constant experience with locating himself and objects in his unseen environment, the blind person brings to the work of programming a skill which helps him tremendously in keeping track of the various alternative pathways of his instructions—a skill which the sighted individual has had little need to acquire. Since the complex logic of some programs may take months or even years for a team of programmers to write and debug, the additional orientation skill of the blind person and his trained memory may well save considerable time for himself and the team.

Educational Prerequisites

A professional programmer may work at varying levels of sophistication. As in any other profession, there are no upper limits to this preparation. However, minimum requirements should be as follows: at least average intelligence with good language and mathematical skills; ability to type fluently or to write readable script; and ability to read braille fluently.

A blind person who meets these requirements may be prepared for a career as a programmer even though he has no more than a high school education. However, the more professional background the blind person acquires, the more desirable an employee he becomes and the better will be his pay. If additional preparation is possible, a two-year study of applied mathematics may be the preferred course. Subjects should include trigonometric functions, three semesters of engineering calculus with emphasis on techniques, a course in numerical analysis, and one or two semesters of linear algebra. When more advanced mathematics present undue difficulties, additional work in business practices and accounting will prove almost as helpful in gaining employment. Statistics and economics courses are also helpful.

A bachelor's degree in applied mathematics with a minor in business makes the professional programmer a more desirable and well-paid employee.

The mutual attraction between blind persons and computers has already enabled a small number of blind persons to acquire programming skills and find gainful and satisfactory employment in the computer industry. For some time, however, these individuals had to rely on help from sighted colleagues; this had prohibited any consistent endeavor of training and placing blind people in computer-related professions. Now the barriers to independent work have been removed, and the number of blind programmers is expected to rise sharply.

Program Preparation

A program may be written directly in machine language or, more commonly, in symbolic form interpreted and assembled into machine language on the computer by a compiling program. Readying a program for execution involves a number of steps. A program is first punched. Each instruction statement goes on a separate card. Because the symbols and their positions on the card have a specific meaning, a precise format must be followed. In addition to the instructions, the programmer also includes remarks which are punched with the instructions and which help him in locating errors.

The original source program is assembled by the computer into machine language by a special compiler program. Some errors (misplaced symbols, illegal statements, etc.) in the program may prevent assembly. If this happens the console indicates, by means of proper lights, the type of error which prevented further assembly and the locations in the program in which this error occurred. This information is returned to the programmer, who makes the necessary corrections.

After assembly, an attempt is made to execute the program on a sample problem. Errors in the program may cause the machine to stop, or may show up by giving incorrect results. Once these errors are corrected and the sample problem is processed correctly, the program is used for the job for which it was intended. Additional errors uncovered at this time are corrected.

Solving Programming Problems

Major difficulties in the preparation of programs are presented by the routines set up to ferret out errors. Very complex programs have to be debugged usually by having the programmer cycle the machine manually through crucial steps and cause it to print intermediate results and partial memory content. Rapid communication between the blind programmer and the machine print-out and console readings are essential, and the ability to operate the machine, while not absolutely necessary, should be a skill the blind programmer posseses. Problems associated with other phases of programming are relatively few.

The blind programmer may choose three methods of getting his program punched:

1. He may punch his cards by himself. Although a card punch is simple to operate, there may be some disadvantages to self-punching. In general, the blind programmer must be able to operate a punch but should avoid punching his own programs; a well-run computing center has clerks who do this job.
2. He may type the program. This is generally satisfactory although slow since the position of characters on the card has to be reflected on the typed-out lines.
3. Specially prepared paper (ribbed or creased according to program format) may be used. The program is written in script, usually pencil, and presents no difficulty to the clerk punch operator.

The only modification necessary for program assembly (listing and memory dump) is that the print-out must be in readable braille. This is achieved by writing a special list and dump program which will cause the machine to print the desired statements in braille. This program, described in MEDCOMP,[*] causes each alphabetical or numerical symbol to be translated into the appropriate braille characters. The minus sign or a period are used for raised dots. Each line of braille is printed in mirror image. The printer is set at highest pressure. The list will then appear as easily-read braille at the back of the sheet.

Paper stiffer than three-ply may also be used; it has the advantage of maintaining readability longer, but the disadvantage of greater expense. The brailler can be made part of the list and dump routines of the computing center. It is fast enough (6,000 translations of alphameric to braille characters a minute) so that no real time loss or extra costs are involved. Special mechanical adaptations of the printing machine are not necessary to programming work.

It is unlikely that an assembled program will be without errors. Simpler programs may be debugged by studying listings, printed memory, and information on signals on the console when the program was halted. Since this information may be supplied in braille by the special brailler program mentioned before, debugging simpler programs for execution does not present special problems to the blind.

For very complex programs such as compilers or monitors it is sometimes desirable for the programmer himself to operate the machine to search for possible location of errors. The error which halts the machine may have occurred in any place in the program that has been executed already. It is necessary for the programmer to read out the content of various locations in memory or cycle the machine manually through parts of the program. The programmer therefore should have the ability to control and read the console.

Control of the console offers no difficulty. Notching or marking of knobs and buttons for specific setting is all that is required. The lights themselves may be covered by a panel to help locate them. The content of memory, instructions and their locations, and error indications are read from the console by means of lights which may appear in many preset locations. It is therefore necessary for the blind operator to be able to read the console (as well as messages appearing on ancillary equipment such as tape drives, printer, card reader, and off-and-on-line subservient computers). The reading of console signals can be accomplished by the use of a light-sensitive probe which translates light into sound. The output of the probe is an audio signal which increases in frequency as the probe scans over a lamp which is turned on. The input section of the console probe is a cadmium sulphide photoconductor with reasonable high sensitivity (4.5 amps/microwatt-luminous). The effective resistance of such a device decreases with increased incedent light. These changes in resistance inversely affect the frequency of oscillation in a simple two-transistor oscillator. The output of the oscillator circuit is then put into a standard 2,000 ohm earphone.

To aid in the use of the probe, a console guide panel is fitted over the console display and isolates the display lights by providing cut-outs over each separate lamp indicator. Braille identification of each cut-out may be easily embedded in or taped beside the cut-out. The blind programmer sitting in front of the console may now effect operations by subsequent touch-and-read signals with the light-sensitive probe.

For printing out sections of memory he can use the braille routine and rely on the printer. Although this procedure is slower than visual inspection, it is faster than having a sighted person work with the blind programmer. Finding complex program errors is much like solving a difficult chess problem and is not aided by chatter nor helped by collaboration. In addition, the blind programmer may make fewer errors because of his general skill in orienting himself in the unseen world of which the internal workings of a computer are just a small part. Complex programs may take months or years to write and debug, and the increased time of computer debugging not only becomes a small part of the over-all time and cost but may be more than offset by the additional skills of the blind programmer.

Training in programming is probably best done in centers equipped and willing to train blind persons. The period of training should include practice on all phases of programming and machine operation and equip the blind worker to write his own brailler for whatever machine he may encounter professionally. Length of training should be six to nine months.

For those who wish to acquire programming skills as part of their training for other work, a shorter stay at a training center may be the best course. However, if an individual wishes to acquire no more than basic principles, he will find adequate instruction at most colleges.

In general, it would appear that the intelligent and qualified blind person should be introduced to computer work as part of his secondary education, preferably during his senior year in high school. This training will equip him

——————————————Continued on page 51

Theodor D. Sterling is director of the Medical Computing Center of the College of Medicine, University of Cincinnati. Responsible for conceiving and directing the work that resulted in publication of this article, Dr. Sterling is also professor of biostatistics in the University's department of preventive medicine and industrial health and recently received the A. Morrison Cressy award in Natural Sciences.

STERLING

Dr. Sterling was aided in his work and in the writing of the article by Michael Lichstein, research assistant; Frank Scarpino, research associate and electrical engineer; Diane Stuebing, instructor in charge of teaching in the new training facility established as part of the center; and William Stuebing, chief engineer of Stuebing Automatic Machine Co., Cincinnati.

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[*] Sterling, T. D., and Pollack, S. V., *MEDCOMP, Handbook of Computer Applications in Biology and Medicine.* Part I: Statistical Systems. Medical Computing Center, College of Medicine, University of Cincinnati, 1964.

Blind Computer Work

(Continued from page 21)

to use computers during his continuing education so that he can become knowledgeable immediately in applications to his chosen field whatever it may be. We are, today, only at the threshold of computer use. The professional opportunities offered through the use of this tool are expanding rapidly. Since in work with computers the blind may operate without handicap and perhaps even with greater ease than the sighted, training in computers should be encouraged regardless of the professional aspiration of the individual.

Knowledge of programming opportunities open to blind persons needs to be disseminated so that qualified individuals can be prepared for a professional career. It is first necessary that rehabilitation workers become more intimately acquainted with employment in the computer industry. It would be desirable for rehabilitation workers and counselors for the blind to take a short course in programming; anyone with average intelligence can master the fundamentals of programming. Such courses are routinely taught by most colleges. Also, IBM has an active teaching program to which rehabilitation workers can gain admittance.

Another group that should become acquainted with the abilities of the blind to do computer work are managers of computer installations and their programming staff. Here the Association for Computing Machinery (ACM) has already undertaken an educational program through a special committee on the blind. On this committee are representatives of the Vocational Rehabilitation Administration, National Institutes of Health, state Divisions of Rehabilitation, and other individuals acquainted with problems of the blind and computing.

Many problems still exist in relation to obtaining actual training. On-the-job training in computer fundamentals does not appear practical. A few centers have indicated their willingness to accept trainees (information on these centers is available from the ACM committee on the blind). It should be possible also to develop self-teaching manuals, which may be used in conjunction with a minimum of tutorial assistance. It should be noted in this connection that a number of commercial schools that purport to teach programming for relatively large fees have been established in larger cities. These establishments are often little better than rackets and are best avoided altogether.

Placing of adequately trained blind persons does not present any difficulty. The ACM committee on the blind plans a placement exchange to facilitate employment. Also, lists of successfully employed blind people and their employers are available for references.

In general, all conditions now exist for insuring adequate training and satisfactory placing of blind trainees in computer-related professions.

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